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ENVIRONMENTAL RESEARCH BRIEF

Pollution Prevention Assessment for a Manufacturer of Metal Fasteners

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Abstract

The U.S. Environmental Protection Agency (EPA) has funded a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the expertise to do so. In an effort to assist these manufacturers Waste Minimization Assessment Centers (WMACs) were established at selected universities and procedures were adapted from the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). That document has been superseded by the *Facility Pollution Prevention Guide* (EPA/600/R-92/088, May 1992). The WMAC team at the University of Tennessee performed an assessment at a plant that manufactures various types of metal fasteners for automobiles, furniture, and appliances. Products are manufactured from steel, brass, copper, and aluminum wire and rod stock in two production lines—large part production and small part production. In large part production, header machines press wire stock into specific product shapes which are washed, machined, and in some cases heat-treated and polished. Small parts are manufactured from wire and rod stock in a series of machining operations, then washed, heat treated and polished, before shipment to an outside firm for surface finishing. The team's report, detailing findings and recommendations indicated that a large amount of plant oil waste is shipped off-site for fuels blending and a significant quantity of oily sludge waste is shipped offsite for disposal as non-hazardous waste. Large cost savings can be achieved by the plant through the use of alternative methods of removing metal chips from parts, thereby reducing intermediate washings.

This Research Brief was developed by the principal investigators and EPA's National Risk Management Research Laboratory, Cincinnati, OH, to announce key findings of an ongoing research project that is fully documented in a separate report of the same title available from University City Science Center.

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Introduction

The amount of waste generated by industrial plants has become an increasingly costly problem for manufacturers and an additional stress on the environment. One solution to the problem of waste generation is to reduce or eliminate the waste at its source.

University City Science Center (Philadelphia, PA) has begun a pilot project to assist small and medium-size manufacturers who want to minimize their generation of waste but who lack the in-house expertise to do so. Under agreement with EPA's National Risk Management Research Laboratory, the Science Center has established three WMACs. This assessment was done by engineering faculty and students at the University of Tennessee's WMAC. The assessment teams have considerable direct experience with process operations in manufacturing plants and also have the knowledge and skills needed to minimize waste generation.

The pollution prevention opportunity assessments are done for small and medium-size manufacturers at no out-of-pocket cost to the client. To qualify for the assessment, each client must fall within Standard Industrial Classification Code 20-39, have gross annual sales not exceeding $75 million, employ no more than 500 persons, and lack in-house expertise in pollution prevention.

The potential benefits of the pilot project include minimization of the amount of waste generated by manufacturers, and reduction of waste treatment and disposal costs for participating plants. In addition, the project provides valuable experi-

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ence for graduate and undergraduate students who participate in the program, and a cleaner environment without more regulations and higher costs for manufacturers.

Methodology of Assessments

The pollution prevention opportunity assessments require several site visits to each client served. In general, the WMACs follow the procedures outlined in the EPA *Waste Minimization Opportunity Assessment Manual* (EPA/625/7-88/003, July 1988). The WMAC staff locate the sources of waste in the plant and identify the current disposal or treatment methods and their associated costs. They then identify and analyze a variety of ways to reduce or eliminate the waste. Specific measures to achieve that goal are recommended and the essential supporting technological and economic information is developed. Finally, a confidential report that details the WMAC's findings and recommendations (including cost savings, implementation costs, and payback times) is prepared for each client.

Plant Background

The plant produces various types of metal fasteners for automobiles, furniture, and appliances. It operates 6,000 hr/yr to produce over 100 million parts annually.

Manufacturing Process

The plant's products are manufactured from steel, brass, copper, and aluminum wire and rod stock in two production lines—large part production and small part production.

In the large part production line, wire stock is fed automatically into header machines in which it is pressed into specific product shapes. The formed parts are transported to a four-stage aqueous parts washer where residual machining oils and metal chips are removed. Then the cleaned parts undergo a series of secondary machining operations including drilling, roll threading, and turning. Parts are rewashed during secondary machining in order to remove metal chips that could interfere with subsequent machining steps. After machining is complete, the parts are sent to auditing for inspection or to the heat treatment area which includes a single-stage wash, a high temperature heat-treat oven, an oil quench, and a draw furnace for stress relief. Heat treated parts are polished in a vibratory finisher. Finally, finished parts are inspected for defects, packaged, and shipped to customers.

Small parts are manufactured from wire and rod stock in a series of machining operations. The stock is drawn and sized and fed into header machines where specific parts are formed. The formed parts are cleaned in a two-stage drum washer where residual lubricant and metal chips are removed. A series of secondary operations, including drilling, tapping, and trimming specific to the product being manufactured, completes the required machining.

After most secondary operations, parts are rewashed in the two-stage drum washer to remove metal chips that could interfere in subsequent machining steps. Then, parts are heat-treated onsite, sent to an outside company for surface finishing, or sent to auditing. Heat-treated parts are polished to remove scale and sent to an outside company for surface finishing. Finally, completed parts are inspected, packaged, and shipped to customers.

An abbreviated process flow diagram for this plant is shown in Figure 1.

Existing Waste Management Practices

This plant already has implemented the following techniques to manage and minimize its wastes.

- An ultrafiltration unit is used to treat oil wastewater onsite. Treated water is reused.
- Water is separated from waste oil in order to make the oil usable for fuels blending offsite.
- A water evaporator is being installed to evaporate excess wastewater that currently is shipped offsite for treatment.

Pollution Prevention Opportunities

The type of waste currently generated by the plant, the source of the waste, the waste management method, the quantity of the waste, and the annual waste management cost for each waste stream identified are given in Table 1.

Table 2 shows the opportunities for pollution prevention that the WMAC team recommended for the plant. The opportunity, type of waste, the possible waste reduction and associated savings, and the implementation cost along with the simple payback time are given in the table. The quantities of waste currently generated by the plant and possible waste reduction depend on the production level of the plant. All values should be considered in that context.

It should be noted that the financial savings of the opportunity, in most cases, results from the need for less raw material and from reduced present and future costs associated with waste management. Other savings not quantifiable by this study include a wide variety of possible future costs related to changing emissions standards, liability, and employee health. It also should be noted that the savings given for each pollution prevention opportunity reflect the savings achievable when implementing each opportunity independently and do not reflect duplication of savings that would result when the opportunities are implemented in a package.

This research brief summarizes a part of the work done under Cooperative Agreement No. CR-814903 by the University City Science Center under the sponsorship of the U.S. Environmental Protection Agency. The EPA Project Officer was **Emma Lou George.**

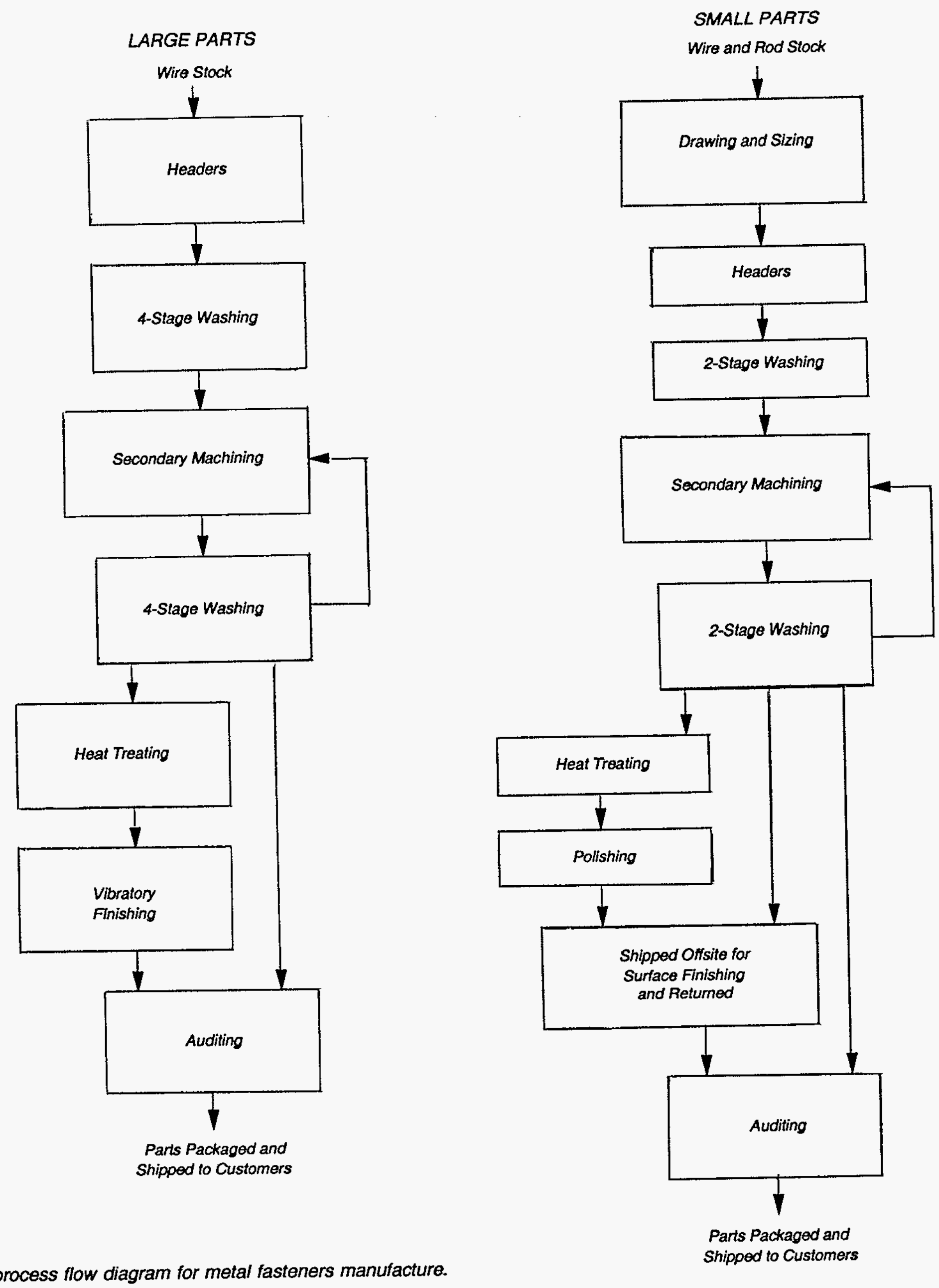

Figure 1. *Abbreviated process flow diagram for metal fasteners manufacture.*

Table 1. *Summary of Current Waste Generation*

Waste Generated	Source of Waste	Waste Management Method	Annual Quantity Generated (lb/yr)	Annual Waste Management Cost*
Petroleum naphtha	Machine part cleaning	Shipped offsite for recycling	9,930	$17,663
Oily sludge	Header clean-out	Shipped offsite as nonhazardous waste	50,000	27,473
Miscellaneous solid waste	General plant operation	Shipped offsite to landfill	500,000	10,100
Waste Oil	Machine clean-out and wastewater treatment	Shipped offsite for fuels blending	82,000	17,250
Scrap metal	Scraps and rejected parts from all operations	Shipped offsite for recycling	Not available	6,500
Waste water	Various processes	Shipped offsite for treatment	448,200	42,600

* Includes waste treatment, disposal, and handling cost, and applicable raw material costs.

Table 2. Summary of Recommended Pollution Prevention Opportunities

Pollution Prevention Opportunity	Waste Reduced	Annual Waste Reduction: Quantity (lb/yr)	Annual Waste Reduction: Percent	Net Annual Savings	Implementation Cost	Simple Payback (yr)
Discontinue intermediate washing between machining operations. As an alternative, install lubricant baths for dipping of parts for metal chip removal.	Wastewater	224,100	50	$19,173[1]	$5,820	0.3
Discontinue intermediate washing between machining operations. As an alternative, use compressed air to blow off metal chips.	Wastewater	224,100	50	19,173[1]	2,020	0.1
Eliminate the use of petroleum naphtha for machine part cleaning. Instead, use the 4-stage washer for machine part cleaning. No additional expense/waste is expected because of the low volume of machine parts that require washing.	Petroleum naphtha	9,930	100	15,663	0	Immediate
Replace disposable paper towels with cloth rags that can be laundered onsite and reused.	Miscellaneous solid waste	25,000	5	11,579[1]	5,400	0.5
Construct collection troughs around leaky machines to reduce use of absorbent "socks" for containment of leaks.	Miscellaneous solid waste	32,000	6	8,424	2,000	0.2
Utilize a cartridge filtration unit to remove dirt and metal fines from waste oil so that it can be reused onsite as lubricating oil in the headers.	Waste oil	26,782	33	6,693[1]	1,500	0.2

[1] Total annual savings have been reduced by an annual operating cost required for implementation.

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